Embedded Intel® Q965 Express Chipset Memory Controller Hub for Embedded Applications

Thermal Design Guide

September 2006

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Contents

Figures

Tables

Revision History

Revision Number	Description	Revision Date
001	Initial public release	September 2006

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1 Introduction

1.1 Overview

This document describes thermal design guidelines for using embedded Intel® Q965 Memory Controller Hub (MCH) in 1U, PICMG*1.3, ATX, and BTX form factors. The objective of designing the thermal solution is to maintain the case temperature of the MCH below the maximum allowable case temperature as specified in the *Intel® Q965 Express Chipset Family Datasheet*. For details of the form factors, please refer to the respective form factor websites for the full specifications. Detailed mechanical and thermal specifications for this product can be found in the *Intel® Q965 Express Chipset Family Datasheet*.

The information provided in this document is for reference only; additional validation must be performed prior to implementing the thermal designs into final production. The intent of this document is to assist embedded OEMs with the development of thermal solutions for their individual designs. It is the responsibility of each OEM to validate the thermal solution design, including the heatsink, attachment method, and thermal interface material (TIM) with their specific applications.

1.2 Document Goals

This document describes the thermal characteristics and reference solution for the Intel® Q965 Express Chipset in the form factors including 1U, PICMG1.3, ATX, and BTX.

1.3 Document Scope

This document includes techniques and consideration for thermal solution design in using the Intel® Q965 MCH in an embedded application. Reference solutions are shared later in the document. Please refer to the product datasheet for the product dimensions, thermal power dissipation, and maximum case temperature. In case of conflict, the data in the product datasheet supersedes any data in this document.

1.4 References

Material and concepts available in the following documents may be beneficial when reading this document.

Document	Source/Reference Number
Intel® 965 Express Chipset Datasheet	313053
Intel® 965 Express Chipset Family Thermal Mechanical Design Guidelines	313055
Intel® I/O Controller Hub 8 (ICH8) Thermal Design Guidelines	313058
Intel® Core™2 Duo Desktop Processor E6000Δ Sequence Thermal and Mechanical Design Guidelines	313685
Intel® Pentium(d) Processor 840, 830, and 820 Datasheet	307506
Intel® Pentium® D Processor 900Δ Sequence and Intel® Pentium® Processor Extreme Edition 955Δ, 965Δ Datasheet	310306
Intel® Pentium® 4 Processor 6x1Δ Sequence Datasheet	310308
Intel® Pentium® D Processor, Intel® Pentium® Processor Extreme Edition, and Intel® Pentium® 4 Processor Thermal and Mechanical Design Guidelines	306830
ATX and BTX System Thermal Design Guide	http://www.formfactors.org/
PICMG 1.3 Specification	http://www.picmg.org/SHB_Express.stm
Thin Electronics Bay Specification	http://ssiforum.org/specifications.aspx

Note: Contact your Intel field sales representative for the latest revision and order number of these documents or to order a document.

1.5 Definition of Terms

Term	Description
CFM	Cubic feet per minute
LFM	Linear feet per minute

Term	Description
PCB	Printed circuit board
T_A	The measured ambient temperature locally surrounding the processor. The ambient temperature should be measured just upstream of a passive heatsink or at the fan inlet for an active heatsink. Also referred to as T_{LA}
T_C	The case temperature of the MCH, measured at the geometric center of the topside of the MCH silicon die.
T_E	The ambient air temperature external to a system chassis. This temperature is usually measured at the chassis air inlets.
T_S	Heatsink temperature measured on the underside of the heatsink base, at a location corresponding to T_C.
$T_{C\text{-}MAX}$	The maximum case temperature as specified in a component specification.
Ψ_{JA}	Junction-to-ambient thermal characterization parameter (psi). A measure of thermal solution performance using total package power. Defined as $(T_J – T_A)$ / TDP. **Note:** Heat source must be specified for Ψ measurements.
Ψ_{JS}	Junction-to-sink thermal characterization parameter. A measure of thermal interface material performance using total package power. Defined as $(Tj – T_S)$ / TDP. **Note:** Heat source must be specified for Ψ measurements.
Ψ_{SA}	Sink-to-ambient thermal characterization parameter. A measure of heatsink thermal performance using total package power. Defined as $(T_S – T_A)$ / TDP. **Note:** Heat source must be specified for Ψ measurements.
TIM	Thermal Interface Material: The thermally conductive compound between the heatsink and the processor case. This material fills the air gaps and voids, and enhances the transfer of the heat from the processor case to the heatsink.
P_{MAX}	The maximum power dissipated by a semiconductor component.
TDP	Thermal Design Power: a power dissipation target based on worst-case applications. Thermal solutions should be designed to dissipate the thermal design power.
Bypass	Bypass is the area between a passive heatsink and any object that can act to form a duct. For this example, it can be expressed as a dimension away from the outside dimension of the fins to the nearest surface.
Thermal Monitor	A feature on the Intel® Pentium® M processor that attempts to keep the processor's die temperature within factory specifications.
TCC	Thermal Control Circuit: Thermal Monitor uses the TCC to reduce die temperature by lowering effective processor frequency when the die temperature is very near its operating limits.
T_{DIODE}	Temperature reported from the on-die thermal diode.
U	A unit of measure used to define server rack spacing height. 1U is equal to 1.75 inches, 2U equals 3.50 inches, etc.

2 Product Specifications

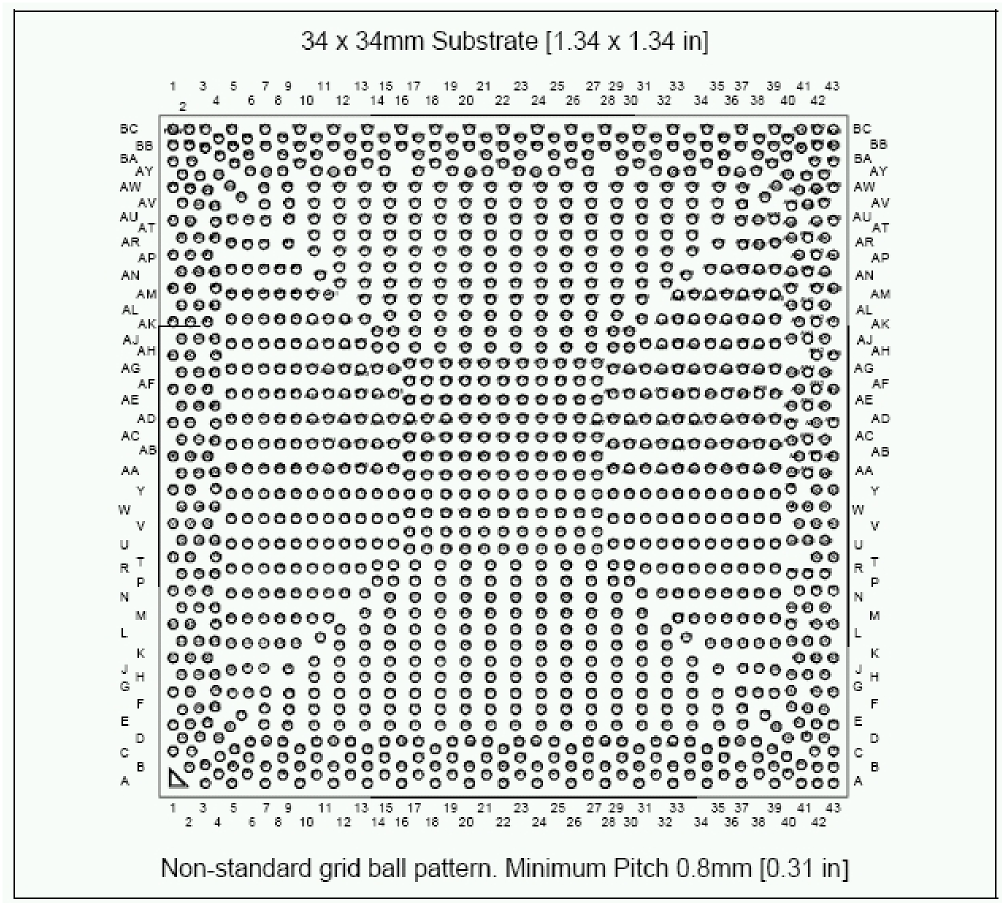
The reference solution presented in this document is targeted for providing a cooling solution in 1U, PICMG1.3, ATX and BTX form factors. Therefore, the thermal solution will have to fit into the solution space as defined in various form factor specifications. The reference solutions could be adopted into other form factors, however, individual assessment and verification should be done.

Performance results provided by the reference solution should be taken as reference only. In addition, the data implies no statistical significance. Therefore, final verification should be based on end user configuration at system integrator or customer area.

2.1 Package Description

The MCH package is measured 34 mm x 34 mm FCBGA package with 1226 solder balls with a die size of 9.6 mm x 10.6 mm. See Appendix B for a mechanical drawing of the package. The MCH package uses the “ball anywhere” where board designer should refer to the Intel® 965 Express Chipset Datasheet for exact ball locations relative to the package.

Figure 1. MCH Non-Grid Array



2.2 Package Loading Specifications

During heatsink assembly, shipping condition or normal use condition, the mechanical maximum loading should not exceed the parameters specified in Table 1. The package substrate should not be used as a mechanical reference or loading-bearing surface for the thermal and mechanical solution.

Table 1. Package Loading Specification

Parameter	Maximum	Notes
Static	15 Lbf	1,2,3

Notes:

1. Uniform compressive loading applied normal to the package
2. Maximum allowed load from the heatsink retention clip. Minimum load must also be achieved to ensure adequate force from the heatsink to the package for heat transfer
3. These specifications are based on limited testing for design characterization. Loading limits are for the package only.

2.3 Thermal Specifications

The purpose of the thermal management is to ensure the case temperature of the MCH is at or below the T_C max as defined in Table 2 in order to achieve product reliability target and proper operation. MCH should also be operating above T_C min as stated in Table 2.

2.3.1 Definition

Thermal Design Power (TDP) is the estimated power dissipation of the MCH based on normal operating conditions, including V_{CC} and T_C-max, while executing real worst-case power intensive applications. This value is based on expected worst-case data traffic patterns and usage of the chipset and does not represent a specific software application. TDP attempts to account for the expected increases in power due to variation in MCH current consumption due to silicon process variation, processor speed, DRAM capacitive bus loading, and temperature. However, since these variations are subject to change, the TDP cannot ensure that all applications will not exceed the TDP value.

The system designer must design a thermal solution for the MCH such that it maintains T_C below T_C max for the sustained power level equal to the TDP. T_C max specification is a requirement for a sustained power level equal to TDP, and case temperature must be maintained at less than T_C max when operating at power less than TDP. The TDP can be used for thermal design if thermal protection mechanisms are enabled. The MCH incorporates a hardware-base failsafe mechanism to keep the product temperature in specification in the event of unusually strenuous usage above the Thermal Design Power.

Table 2. Thermal Design Power

Component	System Bus Speed	Memory Frequency	T_C min	T_C max	Idle Power	TDP
Intel® Q965	1066 MHz	800 MHz	0° C	97° C	13 W	28 W

Note:

1. Thermal specification assumes the presence of an attached heatsink.
2. Idle Power is referred to as a typical part of system booted to Microsoft* Windows* without background application(s).
3. The system configuration is 2 DIMMs per channel, DDR2, FSB operating at top speed allowed by the chipset with a processor operating at the system bus speed. Because of FCBGA package poor heat transfer capability through the board, it is required to have heatsink attached to the package when using MCH.

2.3.2 $T_{CONTROL}$ Limit

Advanced Fan Speed Control monitors are used as embedded thermal sensors. The maximum operating limit when monitoring with this thermal sensor is $T_{CONTROL}$. For the Intel® Q965 MCH, this value has been defined as 95° C. This value should be programmed into the appropriate AFSC register as the maximum sensor temperature for the operation of the MCH.

3 Thermal Metrology

The system designer must measure temperatures in order to accurately determine the thermal performance of the system. Intel has established guideline for the proper techniques for measuring MCH component case temperatures.

3.1.1 Case Temperature Measurements

To ensure functionality and reliability of the MCH the T_C must be maintained at or below the maximum temperature listed in Table 2. The surface temperature measured at the geometric center of the die corresponds to T_C. Measuring T_C requires special care to ensure an accurate temperature reading.

Temperature differences between the temperature of a surface and the surrounding local ambient air can introduce error in the measurements. The measurement errors could be due to several factors:

- poor thermal contact between the thermocouple bead and the surface of the package
- heat loss by radiation and/or convection
- conduction through thermocouple leads
- contact between the thermocouple cement and the heatsink base (if a heatsink is used)

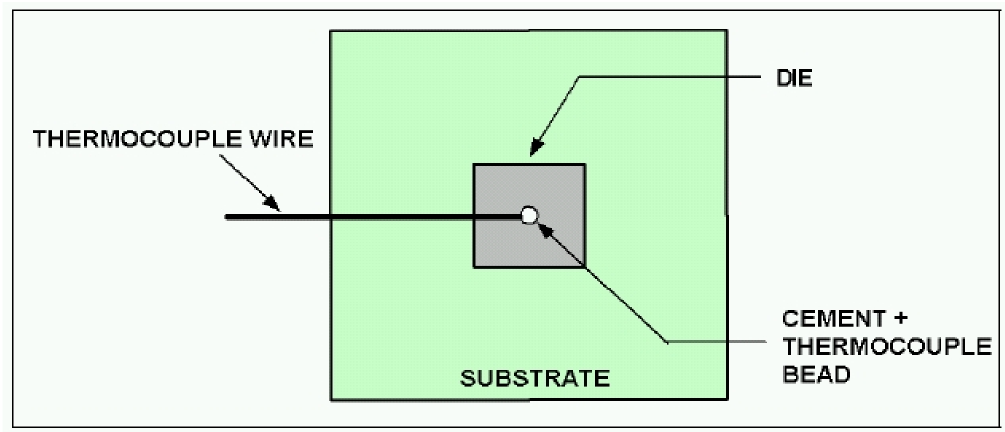
To minimize these measurement errors a thermocouple attach with a zero-degree methodology is recommended.

3.1.2 Thermocouple Attach Methodology

1. Mill a 3.3 mm diameter hole centered on bottom of the heatsink base. The milled hole should be approximately 1.5 mm deep.
2. Mill a 1.3 mm wide slot, 0.5 mm deep, from the centered hole to one edge of the heatsink. The slot should be in the direction parallel to the heatsink fins as shown in Figure 2.
3. Attach thermal interface material (TIM) to the bottom of the heatsink base.
4. Cut out portions of the TIM to make room for the thermocouple wire and bead. The cut-out should match the slot and hole milled into the heatsink base.
5. Attach a 36-gauge or smaller type-K thermocouple bead to the center of the top surface of the die using cement with high thermal conductivity. During this step, make sure no contact is present between the thermocouple cement and the heatsink based because any contact will affect the thermocouple reading. It is critical that the thermocouple bead makes contact with the die as shown in Figure 2.

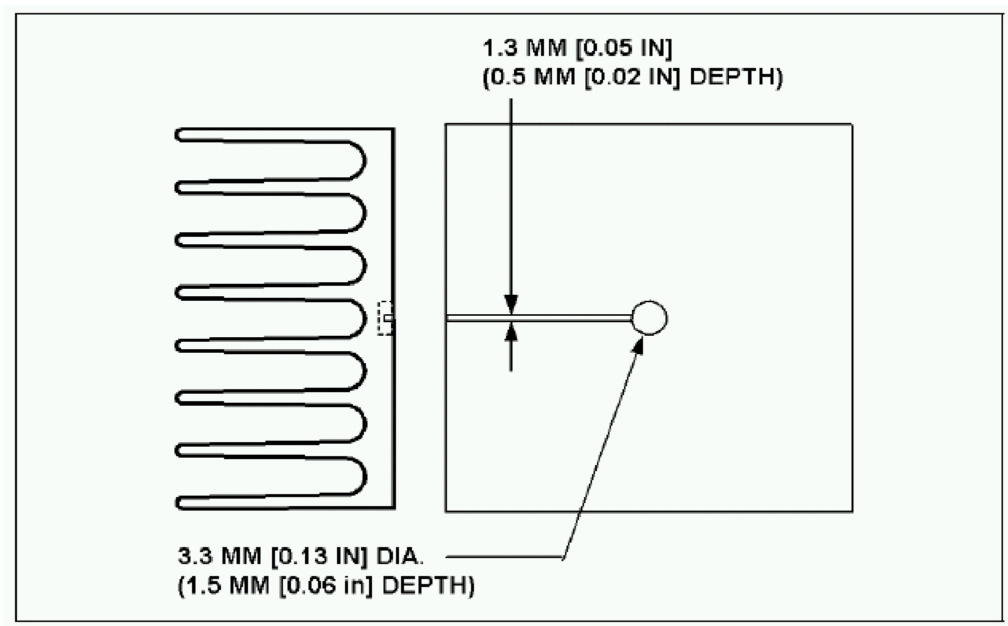
6. Attach heatsink assembly to the MCH, and route thermocouple wires out through the milled slot.

Figure 2. 0° Angle Attach Methodology (TOP VIEW)



Note: Figure not to scale.

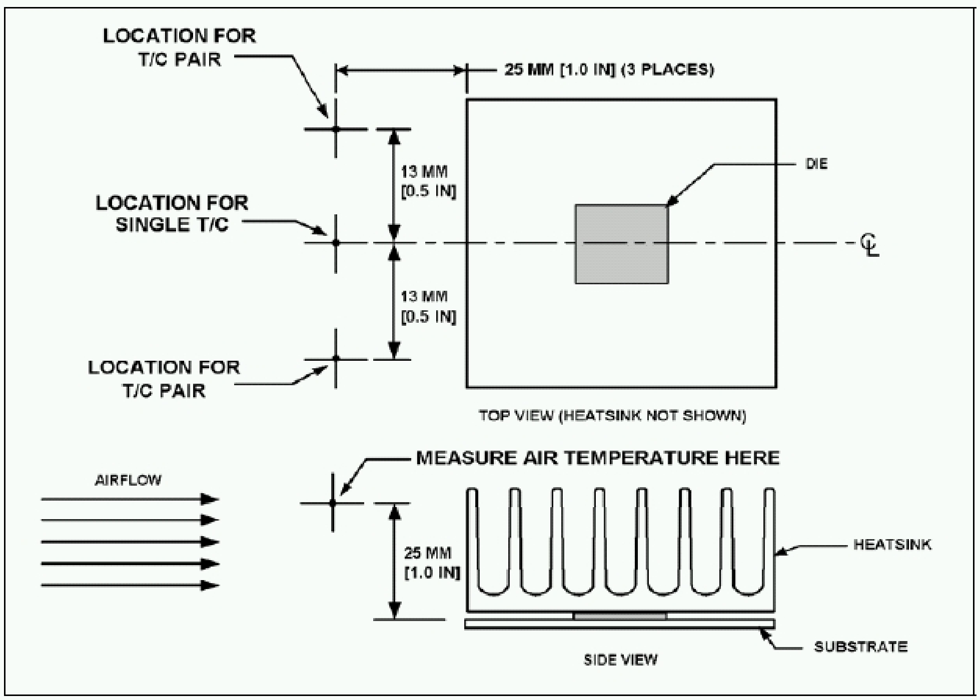
Figure 3. 0° Angle Attach Heatsink Modifications (generic heatsink SIDE and BOTTOM view)



3.2 Air Flow Characterization

The recommended air temperature measurement location is described Figure 4, measured relative to the component. For more accurate measurement of the average approach air temperature, it is recommended that you take the average reading from two thermocouples spaced about 25 mm apart. Locations for single and paired thermocouples are shown in Figure 4.

Figure 4. Air Flow and Temperature Measurement Locations



Air flow velocity can be measured using sensors that combine air velocity and temperature measurements. Typical airflow sensor technology may include hot wire anemometers. Figure 4 provides guidance for airflow velocity measurement locations, which should be the same as used for temperature measurement. These locations are for a typical JEDEC test setup and may not be compatible with chassis layouts due to the proximity of the processor to the MCH. It may be necessary to adjust the locations for a specific chassis. Be aware that sensors may need to be aligned perpendicular to the airflow velocity vector or an inaccurate measurement may result. Measurements should be taken with the chassis fully sealed in its operational configuration to achieve a representative air flow profile within the chassis.

3.3 Thermal Test Vehicle

A thermal test vehicle (TTV) is available for early thermal testing prior to the availability of the actual silicon. The TTV contains heater die and can be powered up to a desired power level to simulate the heating of a MCH package. The TTV must be surface mounted to the custom design board to provide required connectivity to

power up the heater. It is recommended to do final validation using the actual production silicon, even though the TTV is made to match closely to the actual silicon in mechanical form fit. The TTV mechanical features, including die size, ball, count, etc., may not reflect those of the final production package.

Please contact Intel field representative on the availability of the MCH TTV for development needs.

3.4 Thermal Management Guidelines

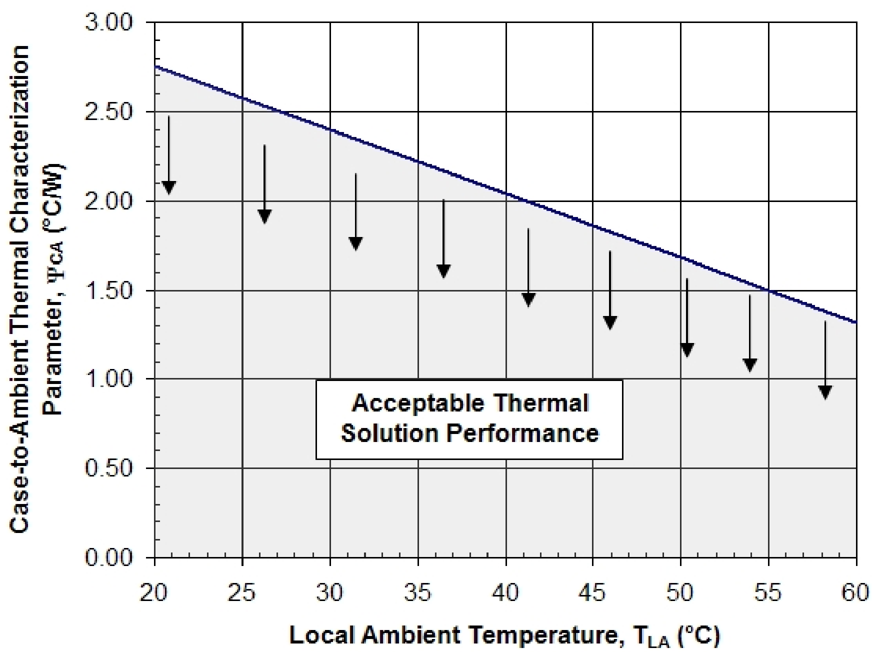
Thermal performance of thermal solution depends on many parameters, including the following product characteristics:

1. Thermal Design Power
2. Maximum case temperature (T_C max)
3. Operating ambient temperature
4. Air flow
5. Interface between thermal solution and silicon die of package (TIM, pressure, flatness, etc.)

It is strongly recommended that the design team validate the reference thermal solution designed and developed with the end use condition, to ensure all environmental variables are considered and reliability of the solution is tested.

Please refer to Figure 5 for the required thermal performance in order to cool the MCH to at or below the T_C max.

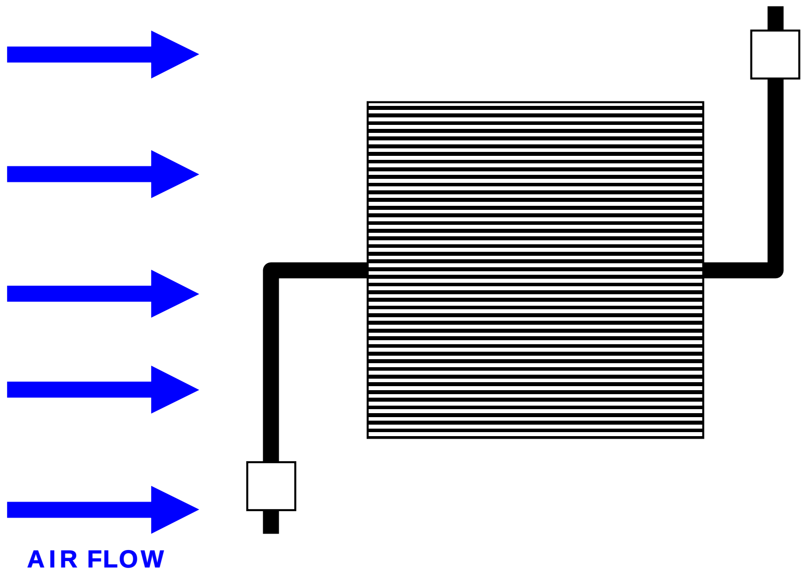
Figure 5. Thermal Performance Requirement



3.4.1 Heatsink Orientation Relative to Airflow

The heatsinks are designed to maximize the available space within the volumetric constraint zone. These heatsinks must be oriented in a specific direction relative to the processor volumetric constraint zone and airflow. In order to use this design, the processor must be placed on the PCB in an orientation such that the heatsink fins are parallel to the airflow. Figure 6 illustrates this orientation with a top view perspective.

Figure 6. Air Flow Direction and Heatsink Fin Orientation



3.4.2 Thermal Interface Material (TIM)

The interface between the processor and heatsink base has a significant impact on the overall thermal solution. Specifically, the bond line thickness, interface material area, and interface material thermal conductivity must be selected to optimize the thermal solution.

It is important to minimize the thickness of the thermal interface material, commonly referred to as the bond line thickness. A large gap between the heatsink base and processor die yields a greater thermal resistance. The thickness of the gap is determined by the flatness of both the heatsink base and the die, plus the thickness of the thermal interface material, and the clamping force applied by the heatsink attachment method. To ensure proper and consistent thermal performance, the TIM and application process must be properly designed.

Another important aspect of Thermal Interface Materials is the degradation of the thermal impedance over the life of the material. The impedance of the TIM increases over the life of the material; this must be taken into account when designing a thermal solution.

The resistance of the thermal solution increases considerably at the End of Life due to the TIM degradation. End of Line for a TIM material is when the TIM is first installed on the heatsink.

End of Life is defined as a time in the future at which the material is deemed to be at the end of its useful life. The End of Life time varies for TIM material. It is recommended that thermal solution designers work with TIM manufacturers to determine the performance of the thermal interface material and its expected End of Life time length. System integrators might wish to replace the TIM during regularly

scheduled maintenance periods in order to maintain End of Life performance of the thermal solution.

The heatsink solution was optimized using a high-performance phase-change material (PCM) Thermal Interface Material (TIM) with low thermal impedance, e.g. Honeywell* PCM45 thermal phase-change material. Vendor information for this material is provided in Appendix A. Alternative materials may also be used. The entire heatsink assemblies, including the heatsink attach method, and thermal interface material, must be validated together for specific applications.

3.4.3 Solder-Down Anchors

For platforms that have very limited board space, a clip retention solder-down anchor has been developed to minimize the impact of clip retention on the board. It is based on a standard three-pin jumper and is soldered to the board like any through-hole header. A new anchor design is available with 45° bent leads to increase the anchor attach reliability over time. The part number and vendor information is contained in Appendix A.

4 Reference Thermal Solution

For ATX form factor, the MCH ATX reference solution will reuse the ramp retainer, extrusion design and anchors. The TIM and a wire preload are being re-designed to meet the MCH thermal requirement.

For BTX form factor, the MCH BTX reference solution will include a new extrusion, clip with higher preload, and a new thermal interface material. Keep out zone for the solution will be larger than the previous MCH.

4.1 ATX Form Factor Operating Environment

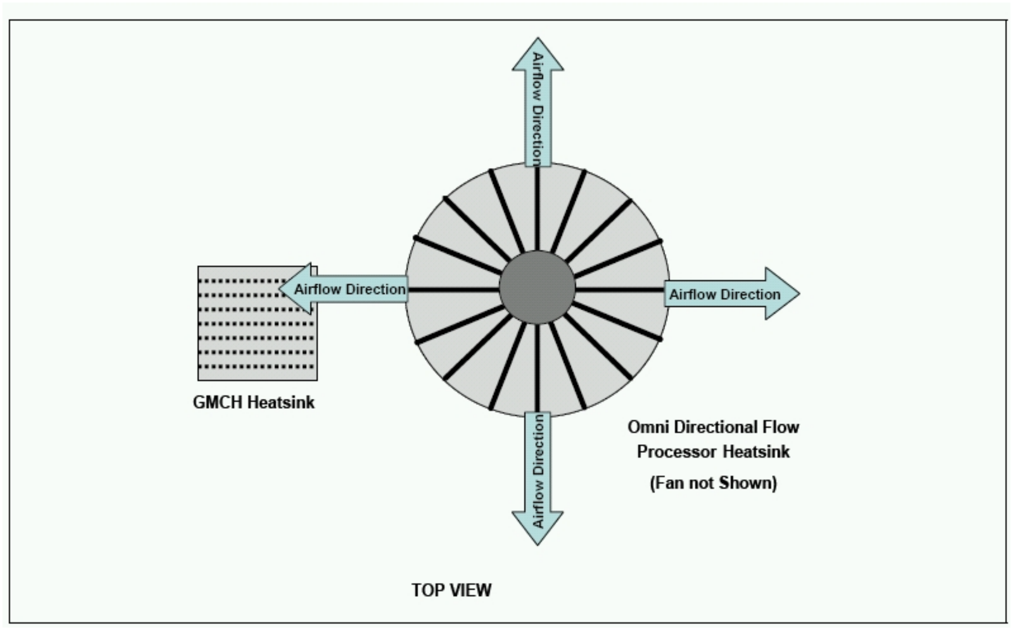
In ATX platforms, airflow speed of 0.76 m/s [150 fm] is expected to be present 25 mm in the front of the heatsink air inlet or upstream of the air flow into the heatsink. The local ambient temperature, TLA, at the MCH is assumed to be 47° C. The intake air temperature is estimated based on processor active heatsink exhaust air; therefore, it is higher than room temperature. The system integrator should note that board layout may be such that there will not be 25 mm between the processor heatsink and the MCH. There is a potential increase of air flow speed by ensuring airflow from processor heatsink fan exhaust to MCH heatsink air inlet. This can be achieved by using a heatsink providing multi-directional airflow, such as a radial fin or “X” pattern heatsink. Such heatsink can deliver air flow to both MCH and other areas like voltage regulator. Also, MCH placement on board should be within the air exhaust area of the processor heatsink.

The heatsink orientation alone does not ensure that 0.76 m/s [150 LFM] airflow speed will be achieved. The system integrator should use analytical or experimental means to determine if a system design provides adequate air flow speed for a particular MCH heatsink.

The thermal solution designer must carefully select the location to measure airflow to get a representative sampling. These environment assumptions are based on 35° C system external temperature measured at sea level.

Please refer to Figure 7 for processor heatsink exhaust orientation with respect to MCH heatsink in ATX platform.

Figure 7. Processor Heatsink Orientation to Provide Airflow to MCH Heatsink on an ATX Platform



Other methods exist for providing airflow to the MCH heatsink, including the use of system fans and/or ducting, or the use of an attached fan (active heatsink).

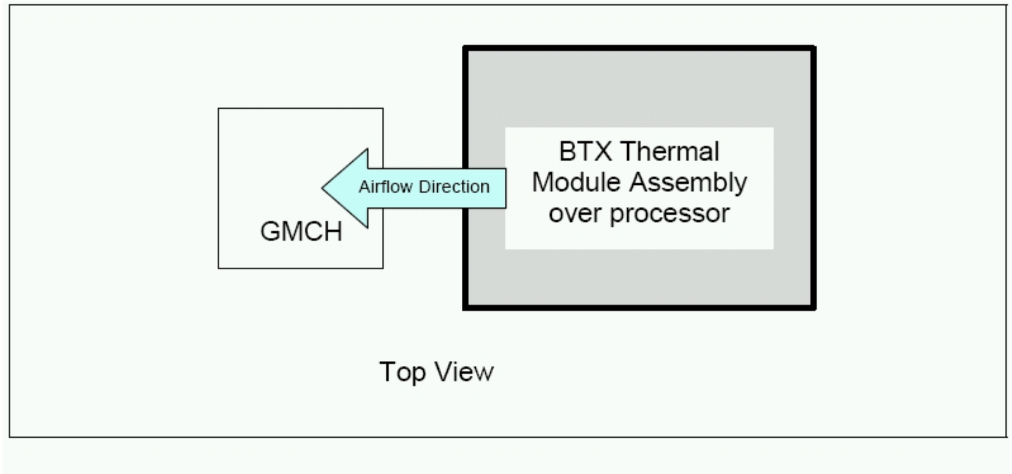
4.2 BTX Form Factor Operating Environment

In the BTX form factor, the operating environment conditions will be modeled after the Intel micro-BTX reference design. In BTX, the MCH obtains an in-line airflow directly from the processor thermal module. Since the processor thermal module provides lower inlet temperature airflow to the processor, reduced inlet ambient temperatures are usually observed at MCH as compared to ATX. Please refer to Figure 8 on how air flow is delivered to MCH on a BTX platform.

The local ambient air temperature, TLA, at the MCH heatsink in the Intel micro-BTX reference design is predicted to be ~45° C. The thermal solution designer must carefully select the location to measure air flow to get a representative sampling. The environment sampling assumptions are based on a 35° C system external temperature measured at sea level.

Note: The local ambient air temperature is a projection based on the power for a 2005 platform, processor TDP up to 130 W, and are subject to change based on the latest update on the processor datasheet.

Figure 8. Processor Heatsink Orientation to Provide Airflow to MCH heatsink on a BTX Platform



4.3 Operating Environment for 1U/ PICMG 1.3 Form Factors

The reference thermal solution compatible with the 1U form factor was designed assuming a maximum local ambient air temperature, TLA, of 40° C with a minimum airflow velocity of 200 lfm [1.02 m/s] present 25 mm [1 in.] directly in front of the heatsink air inlet side. The system integrator should note that board layout may be such that there will not be 25 mm [1 in.] between the processor heatsink and the MCH. The potential for increased airflow speeds may be realized by ensuring that airflow from the processor thermal solution exhaust are in the direction of the MCH heatsink. In addition, MCH board placement should ensure that the MCH heatsink is within the air exhaust area of the processor heatsink. An example of typical 1U server layout is shown in Figure 9. This layout is based on the *Thin Electronics Bay* specification located at http://www.ssiforum.org. As an added advantage, the MCH can be located in an area that has a direct fresh air flow. Refer to Figure 9.

Assuming these boundary conditions are met, the reference thermal solutions will meet the thermal specifications for the MCH. Table 4 shows the required thermal performance for the Intel MCH. The thermal designer must carefully select the location to measure airflow to get a representative sampling. These environmental assumptions are based on a system at sea level.

The 1U reference heatsink solution can also be implemented into a PICMG1.3 SHB which has 1U to an adjacent board or card. See details shown at Figure 11

Figure 9. 1U System Mechanical Layout

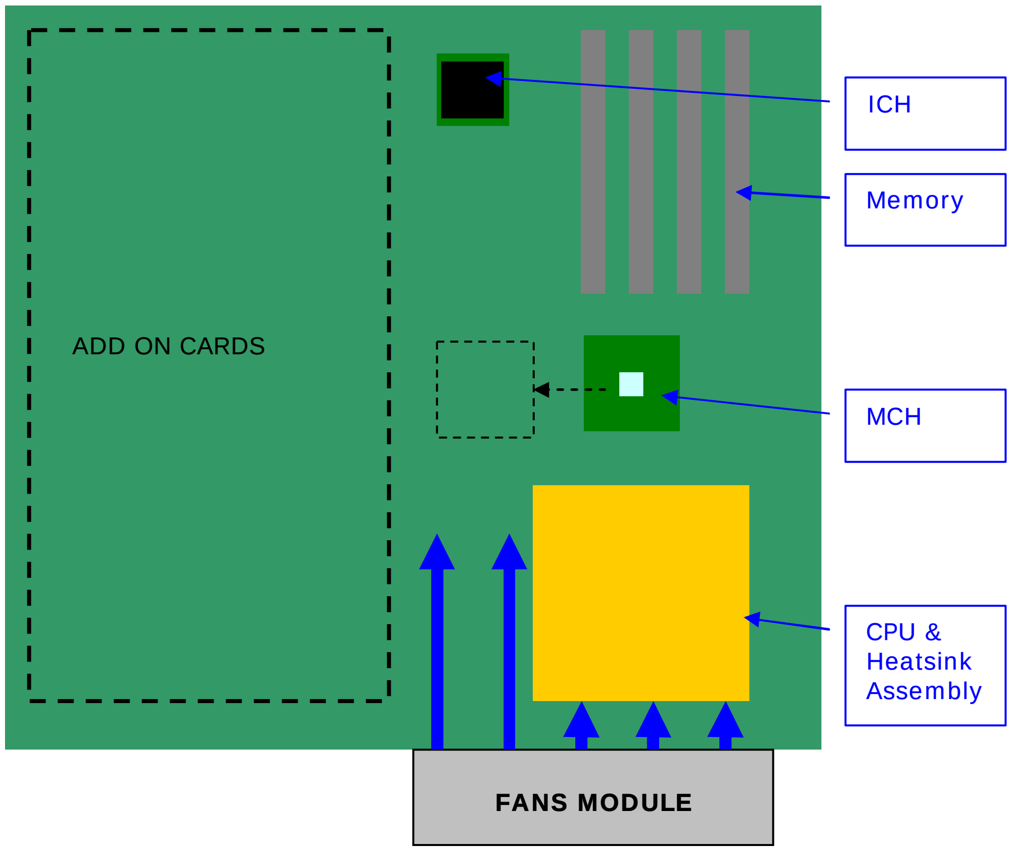
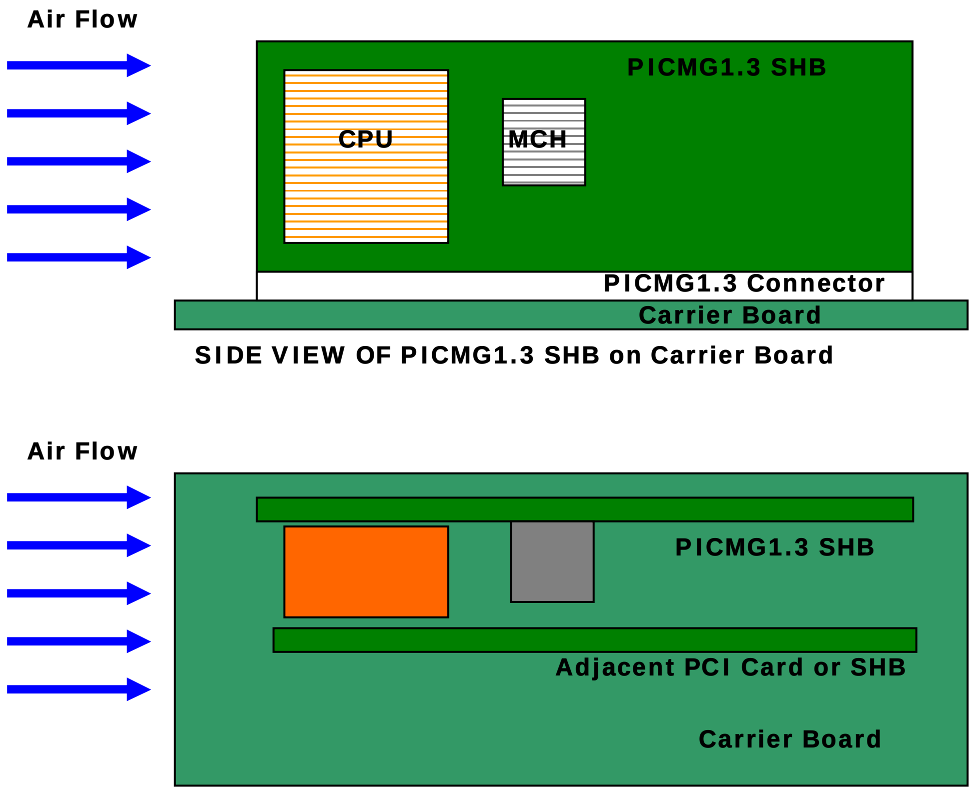


Figure 10. Reference Heatsink for PICMG1.3 Form Factor



TOP VIEW OF SHB PICMG1.3 on Carrier Board

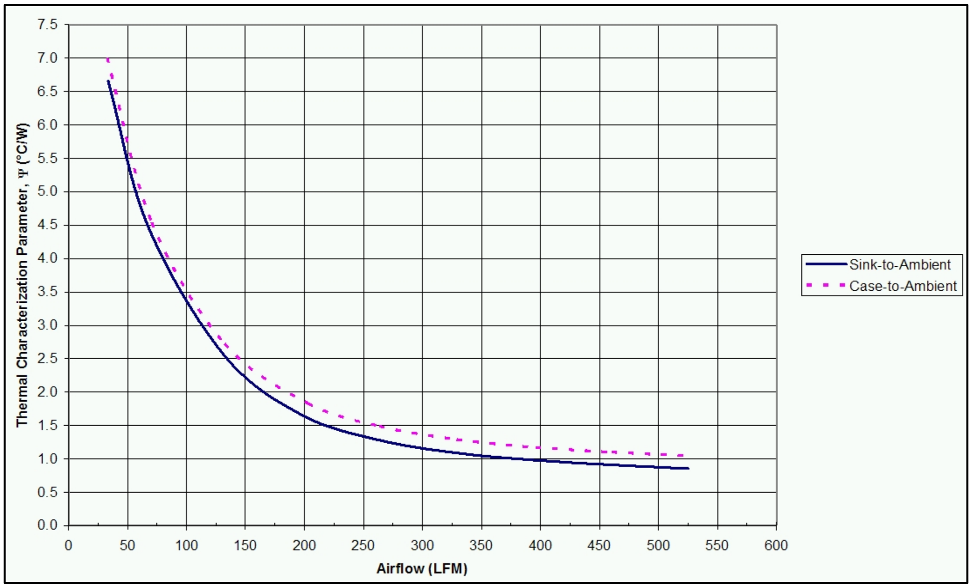
4.3.1 Thermal Performance of 1U / PICMG 1.3 Reference Solution

For environment at TLA of 40° C and 55° C, the required thermal resistance will be 2.03 C/W and 1.50 C/W respectively.

Based on the performance curve shown in Figure 11, at TLA of 40° C and 55° C, it will require 180 LFM and 250 LFM to cool the MCH within its Tc-max specification.

Because of the high thermal performance required, it is recommended to have the MCH move to the higher air flow location as shown in Figure 11.

Figure 11. 1U/PICMG1.3 Thermal Performance of MCH Reference Solution



4.4 Reference Design Mechanical Envelope

The motherboard component keep-out restrictions for the MCH for a 1U or PICMG1.3, ATX and BTX are included in Appendix B.

4.5 Thermal Solution Assembly

The reference thermal solutions for the MCH in ATX, BTX and 1U/PICMG1.3 are shown in Figure 12, Figure 13 and Figure 14 respectively.

The ATX MCH thermal solution consists of an extruded aluminum heatsink that uses two ramp retainers, a wire preload clip, and four motherboard anchors. Refer to Appendix B for the mechanical drawing. The heatsink is attached to the board by assembling the anchors into the board, placing the heatsink over the MCH and anchors at each of the corners, and securing the plastic ramp retainers through the anchor loops before snapping each retainer into the fin gap. The assembly is then sent through the wave soldering process. After power wave soldering, the wire preload clip is assembled using the hooks on each of the ramp retainers. This provides mechanical preload to the package. A thermal interface material (Honeywell* PCM45F) is pre-applied to the heatsink bottom over an area which contacts the MCH package die.

Note: The ATX MCH heatsink design is similar in appearance to the Intel® 945G Express Chipset thermal solution, but two critical items are changed:

- A higher performance TIM
- A clip with higher preload to meet the TIM preload requirement

The two new items above provide the performance increase of the thermal solution to meet MCH thermal requirement.

For more details of the ATX MCH heatsink solution, please refer to *Intel® 965 Express Chipset Family Thermal/Mechanical Design Guidelines*.

Figure 12. ATX MCH Heatsink - Mounted on Board

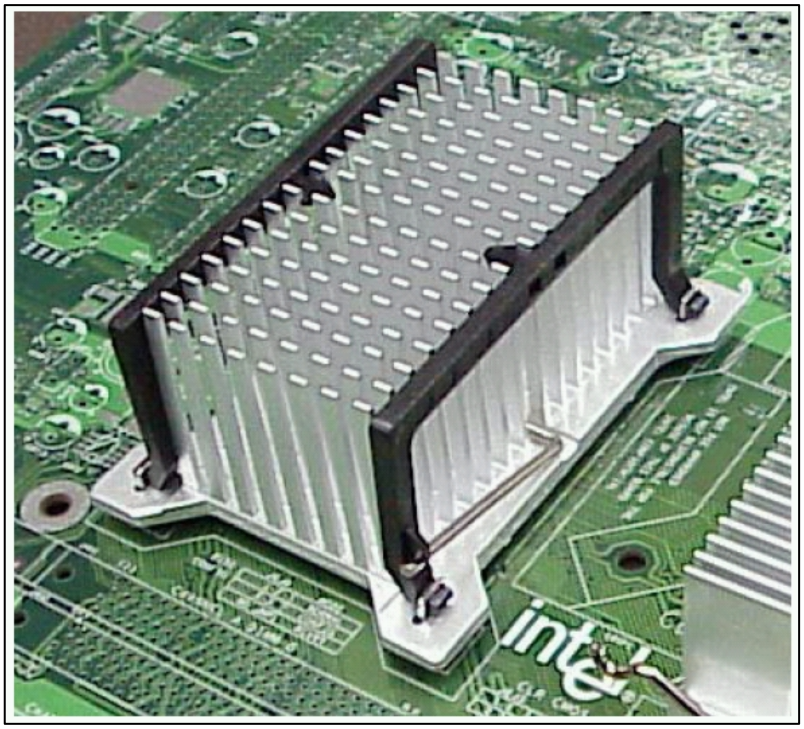
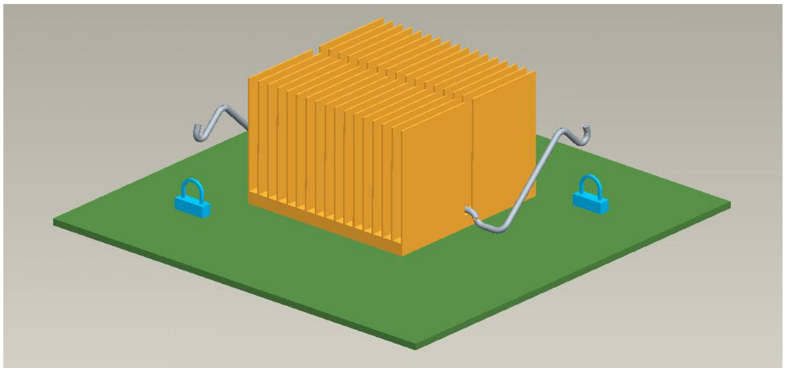


Figure 13. BTX MCH Heatsink - Mounted on Board

The reference thermal solution for MCH in BTX system is show at Figure 13. It consists of an aluminum extruded heatsink and Z-clip for heatsink to board attach. The clip is secured to the system motherboard via two soldered down anchors around the MCH. See the anchor locations in the mechanical drawing in Appendix B. The clip helps to provide mechanical preload to MCH through the heatsink. TIM (Honeywell* PCM45F) is pre-applied to the heatsink bottom over an area in contact with the package die. Please refer to *Intel® 965 Express Chipset Family Thermal Mechanical Design Guidelines* for more details of MCH Heatsink in BTX System.

Figure 14. 1U/PICMG1.3 MCH Heatsink - Mounted on Board



4.6 Environment Reliability Requirements

The environmental reliability requirements for the reference thermal solution are shown in Table 3. These should be considered as general guidelines. Validation test plans should be defined based on anticipated use conditions and resulting reliability requirements.

The ATX testing will be performed with the sample board mounted on a test fixture including a processor heatsink with a mass of 550 g. The test profiles are unpackaged board level limits.

Table 3. ATX Reference Thermal Solution Environmental Reliability Requirements (Board Level)

Test[1]	Requirement	Pass / Fail Criteria[2]
Mechanical Shock	• Three drops for + and – directions in each of Three perpendicular axes, (total 18 drops) • Profile: 50 G. Trapezoidal waveform, 4.3 m/s minimum velocity change	Visual / Electrical Check/Thermal Performance
Random Vibration	• Duration: 10 min/axis, three axes • Frequency Range: 5 Hz to 500 Hz • Power Spectral Density (PSD) Profile: 3.13 g RMS	Visual / Electrical Check/Thermal Performance
Thermal Cycling	• -40° to + 85° C, 900 cycles	Thermal Performance
Unbiased Humidity	• 85 % relative humidity / 85° C, 576 hours	Visual Check

NOTES:

1. Tests should be performed on a sample size of at least 12 assemblies from three different lots of material.

2. Additional pass/fail criteria may be added at the discretion of the user.

The BTX reference solution testing is to mount the sample board in a BTX chassis with thermal module assembly mounted having a mass of 900 g. The test profiles are unpackaged system limits. See Table 4 for details.

Table 4. BTX Reference Thermal Solution Environmental Reliability Requirements (System Level)

Test[1]	Requirement	Pass / Fail Criteria[2]
Mechanical Shock[3]	• Two drops for + and – directions in each of three perpendicular axes, (total 12 drops) • Profile: 25 G. Trapezoidal waveform, 5.7 m/s minimum velocity change	Visual / Electrical Check/ Thermal Performance
Random Vibration	• Duration: 10 min/axis, three axes • Frequency Range: 0.001 g 2/Hz @ 5 Hz, ramping to 0.01 g 2/Hz @ 20 Hz, 0.01 g 2/Hz @ 20 Hz to 500 Hz • Power Spectral Density (PSD) Profile: 2.20 g RMS	Visual / Electrical Check/ Thermal Performance
Power Cycling	• 7500 cycles (on / off) of minimum temperature min 27 / max 96 • 1400 cycles (on / standby) min 35 / max96 • 15 seconds dwell at high / low for both cycles	Thermal Performance – TIM Degradation
Unbiased Humidity	• 85 % relative humidity / 85° C, 576 hours	Visual Check

NOTES:

1. The above tests should be performance on a sample size of at least 12 assemblies from three different lots of material.
2. Additional Pass/ Fail criteria may be added at the discretion of the user.
3. Mechanical Shock minimum velocity change is based on a system weight of 20 to 29 lbs.

For the chassis level testing, the system will include: 1 HDD, 1 ODD, 1 PSU, 2 DIMMs and the I/O shield.

Table 5. 1U / PICMG 1.3 Reference Thermal Solution Environmental Reliability Requirements

Test[1]	Requirement	Pass/Fail Criteria[2]
Mechanical Shock	• Three drops for + and - directions in each of three perpendicular axes (total 18 drops). • Profile: 50 G trapezoidal waveform, 11 ms duration, 4.3 m/s [170 in/s] minimum velocity change. • Setup: Mount sample board on test fixture. Include 550 g processor heatsink.	Visual\Electrical Check Cross section should have crack length < 50 %
Random Vibration	• Duration: 10 min/axis, three axes • Frequency Range: 5 Hz to 500 Hz • Power Spectral Density (PSD) Profile: 3.13 g RMS	Visual/Electrical Check Cross section should have crack length < 50 %
Thermal Cycling	• -40° C to +85° C, 900 cycles	Thermal Performance
Unbiased Humidity	• 85 % relative humidity / 55° C, 1000 hours	Visual Check

NOTES:

1. The above tests should be performed on a sample size of at least 12 assemblies from 3 different lots of material.

2. Additional Pass/Fail Criteria may be added at the discretion of the user.

Appendix A: Enabled Suppliers

These vendors and devices are listed as a convenience to the embedded customer base, but Intel does not make any representation or warranty whatsoever regarding quality, reliability, functionality, or compatibility of these devices. The list and/or these devices may be subject o change without notice.

Table 6. ATX Intel Reference Heatsink Enabled Suppliers for MCH

ATX ITEMS	Intel Part Number	AVC	CCI	Foxconn	Wieson
Heatsink & TIM	D31682-001	S902Y10001	3351833301A	2Z802-032	
Plastic clip	C85370-001	P109000024	334C863501A	3EEE77-002	
Wire Clip	D29082-001	A208000233	3341833301A	3KS02-155	
Anchor	C85376-001			2Z802-015	G2100C888-143

Table 7. BTX Intel Reference Heatsink Enabled Suppliers for MCH

BTX ITEMS	Intel Part Number	AVC	CCI	Foxconn	Wieson
Heatsink assembly (HS, wire clip & TIM)	D34258-001	S905Y10001	001833201A	2ZQ99-066	
Anchor, LF	A13494-008			HB9703E-DW	G2100C888-064H

Table 8. 1U / PICMG1.3 Intel Reference Heatsink Enabled Suppliers for MCH

Component	Supplier	Intel Part Number	Vendor Part Number	Contact Information
1U Copper Heatsink gasket, and pre-applied Honeywell* PCM45F TIM	Cooler Master*	N/A	ECB-00265-01-GP	Wendy Lin (USA) (510)770-8566 ext. 211 wendy@coolermaster.com
Thermal Interface Material	Honeywell*	N/A	PCM45F	Paula Knoll 858-279-2956 Paula_knoll@honeywell.com

Component	Supplier	Intel Part Number	Vendor Part Number	Contact Information
Heatsink Attach Clip	CCI/ACK*	A69230-001	N/A	Harry Lin (USA) 714-739-5797 hlinack@aol.com Monica Chih (Taiwan) 866-2-29952666, x131 Monica_chih@ccic.com.tw
	Foxconn*		N/A	Bob Hall (USA) 503-693-3509, x235 bhall@foxconn.com
Solder-down Anchor	Foxconn*	A13494-005	N/A	Julia Jiang (USA) 408-919-6178 juliaj@foxconn.com

Table 9. Supplier Contacts

Supplier	Contacts	Phone	Email
AVC (Asia Vital Components)	David Chao	+886-2-2299-6930 ext.7619	David_chaoi@avc.com.tw
	Raichel Hsu	+886-2-2299-6930 ext.7630	Raichel_hsi@avc.com.tw
CCI (Chaun Choung Technology)	Monica Chih	+886-2-2995-2666	Monica_chih@ccic.com.tw
	Harry Lin	+1(714) 739-5797	hlinack@aol.com
Foxconn	Jack Chen	+1(714) 626-1233	Jack.chen@foxconn.com
	Wanchi Chen	+1(714) 626-1376	Wanchi.chen@foxconn.com
Wieson Technologies	Andrea Lai	+886-2-2647-1896 ext.6684	Andrea24@wieson.com
	Edwina Chu	+886-2-2647-1896 ext.6390	edwina@wieson.com

Appendix B: Mechanical Drawings

The following table lists the mechanical drawings available in this document.

Figure 15. MCH Pakcage Drawing

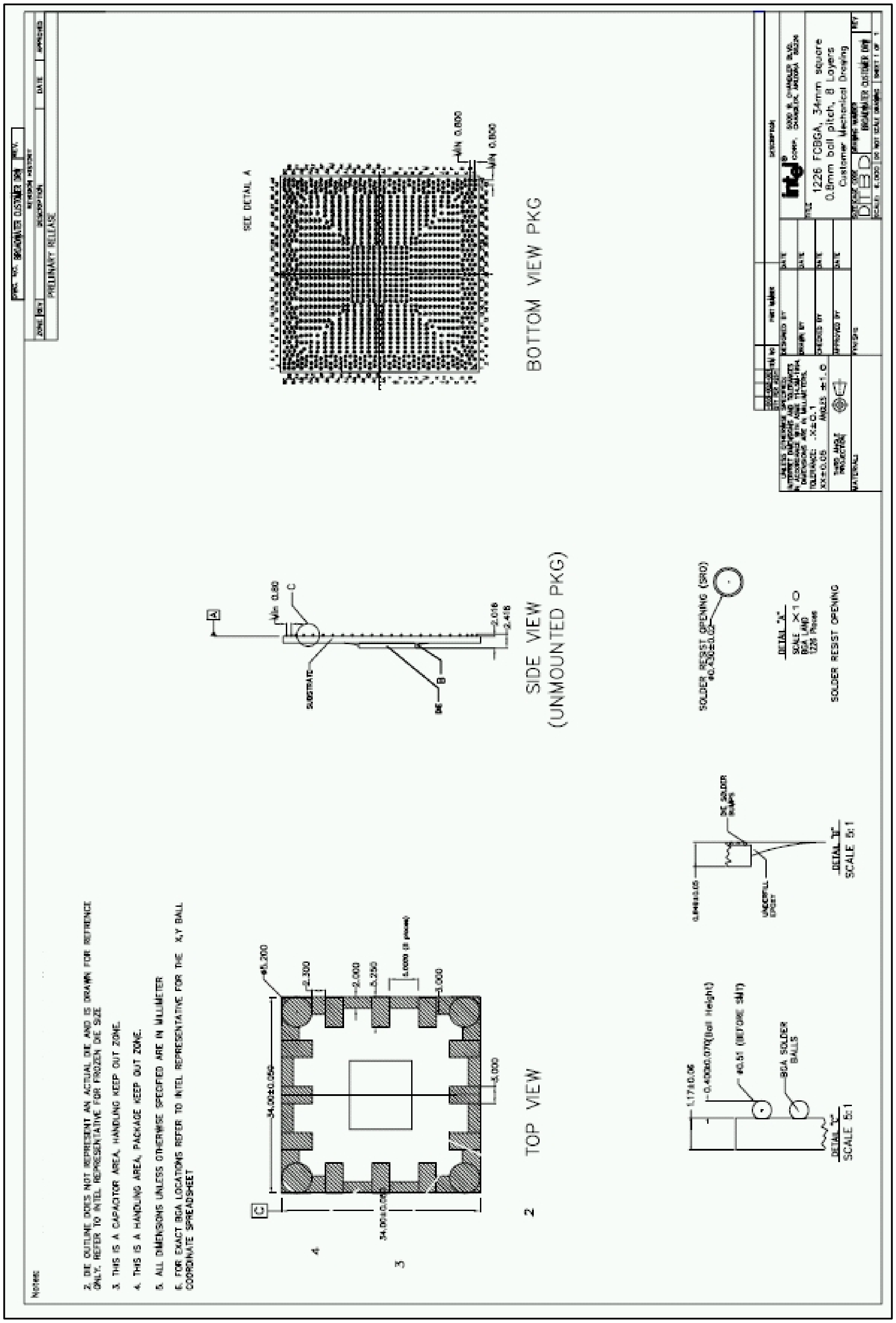


Figure 16. MCH Component Keep-Out Restriction for ATX Platforms

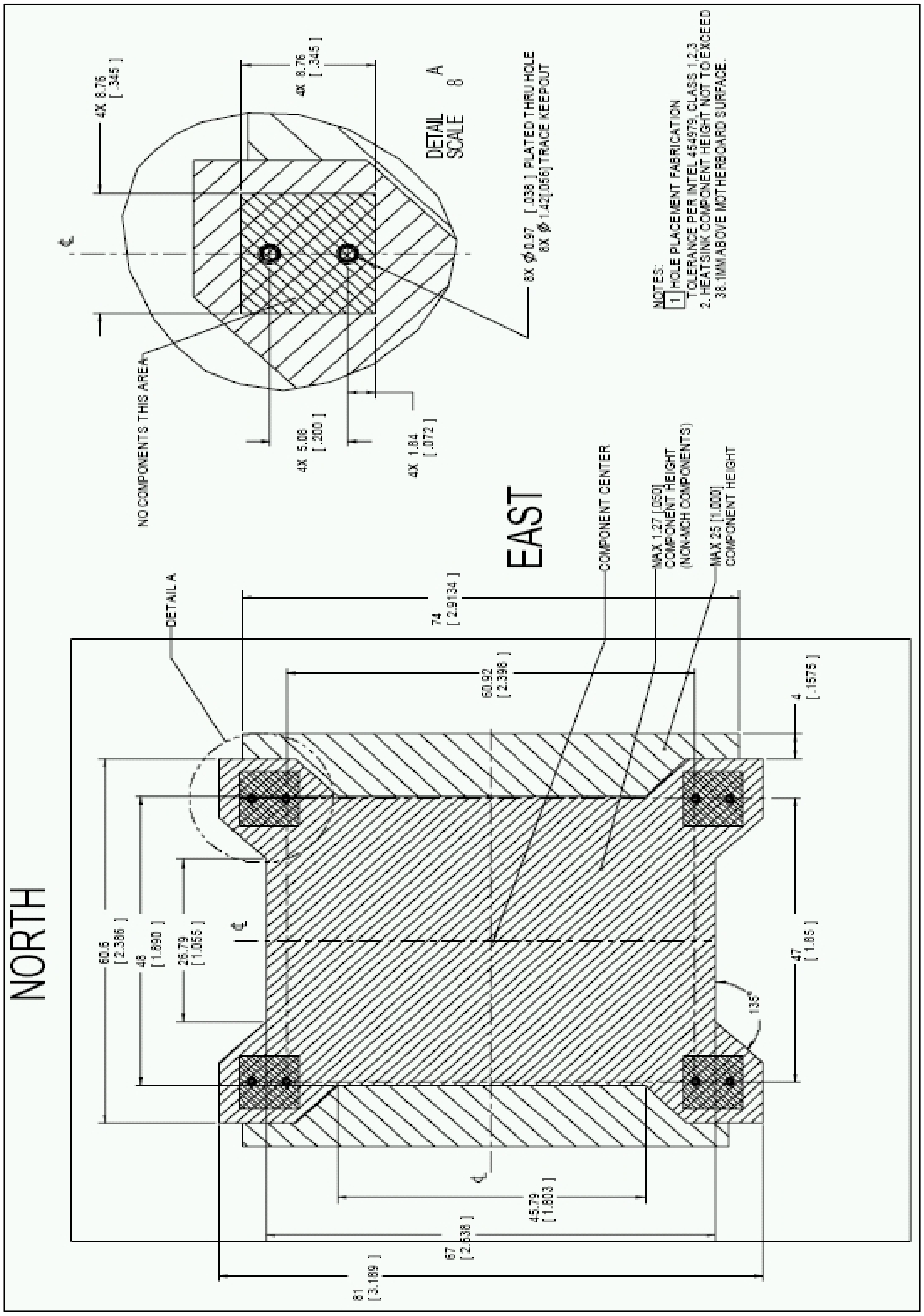


Figure 17. MCH Reference Heatsink for ATX Platforms - Sheet 1

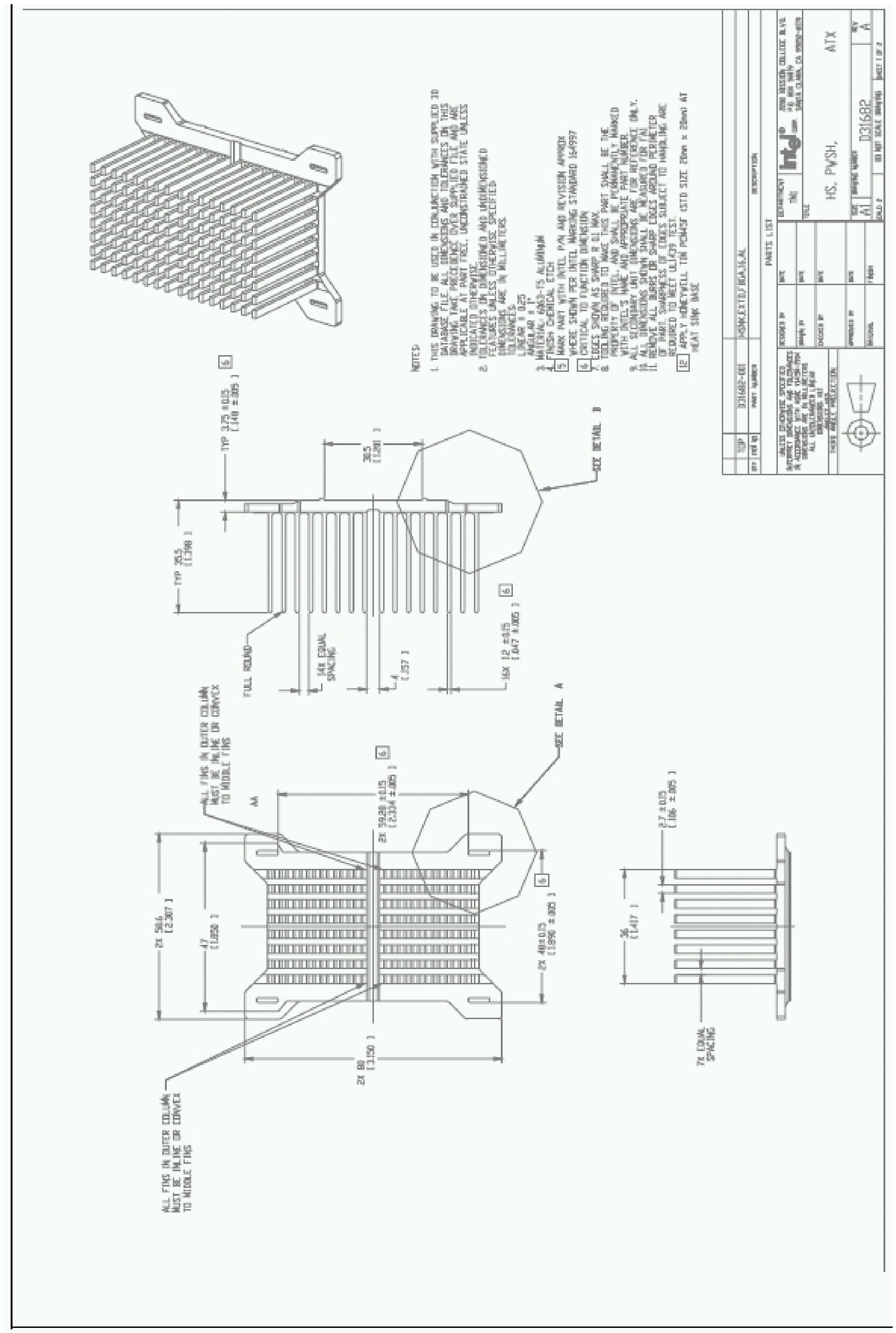


Figure 18. MCH Reference Heatsink for ATX Platforms - Sheet 2

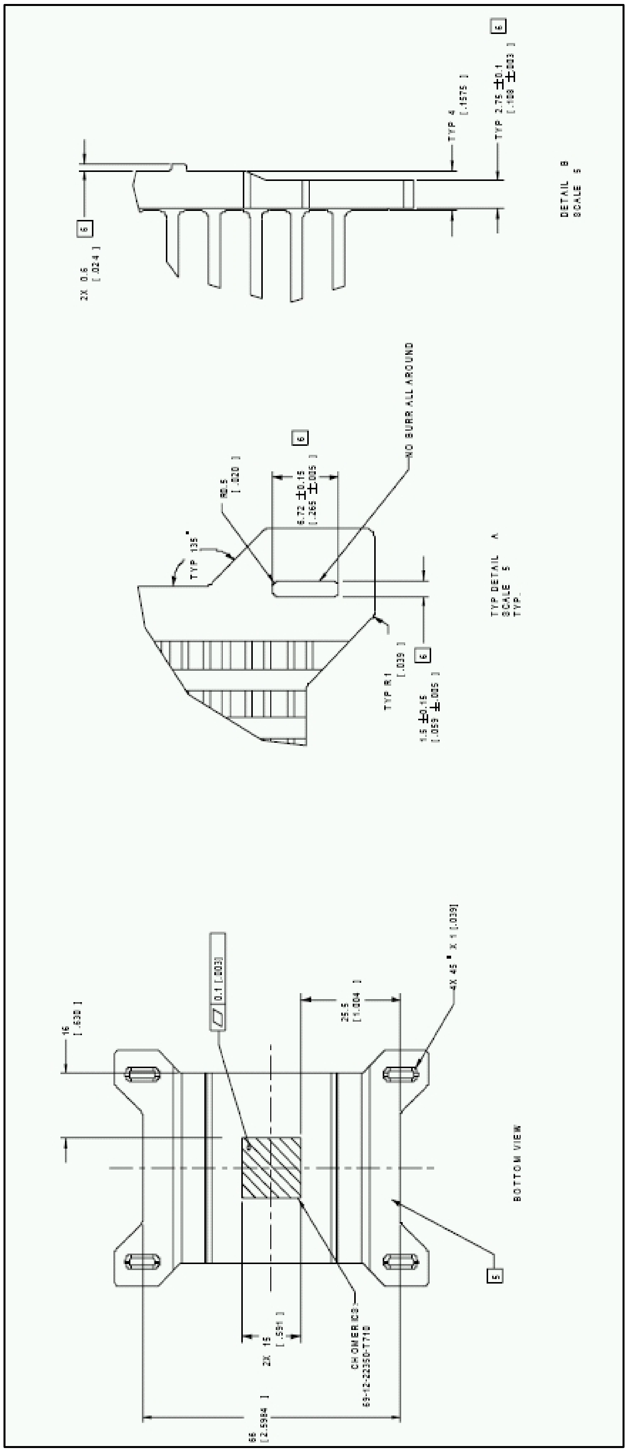


Figure 19. MCH Heatsink for ATX Platforms - Anchor

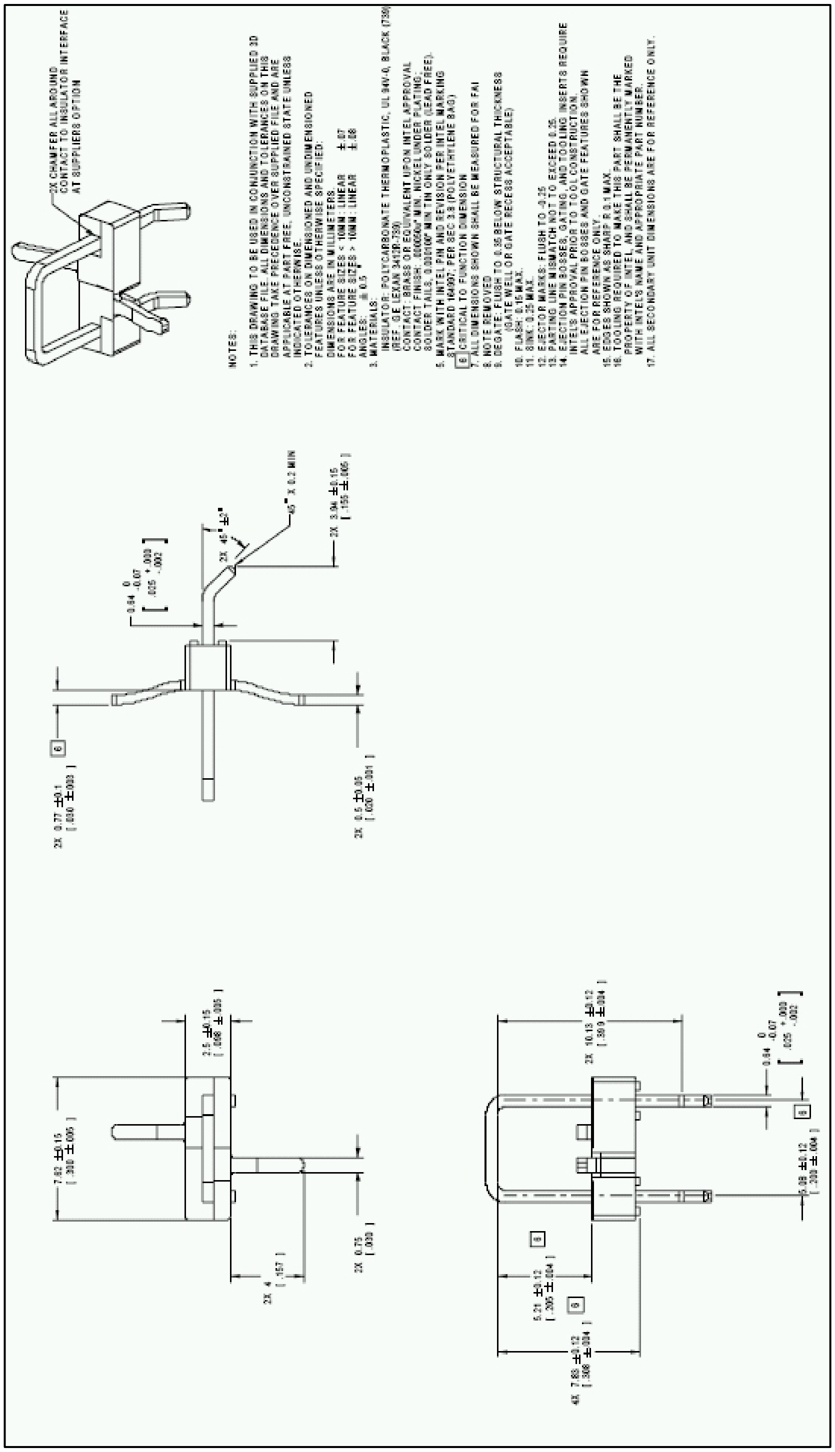


Figure 20. MCH Reference Heatsink for ATX Platforms - Ramp Retainer Sheet 1

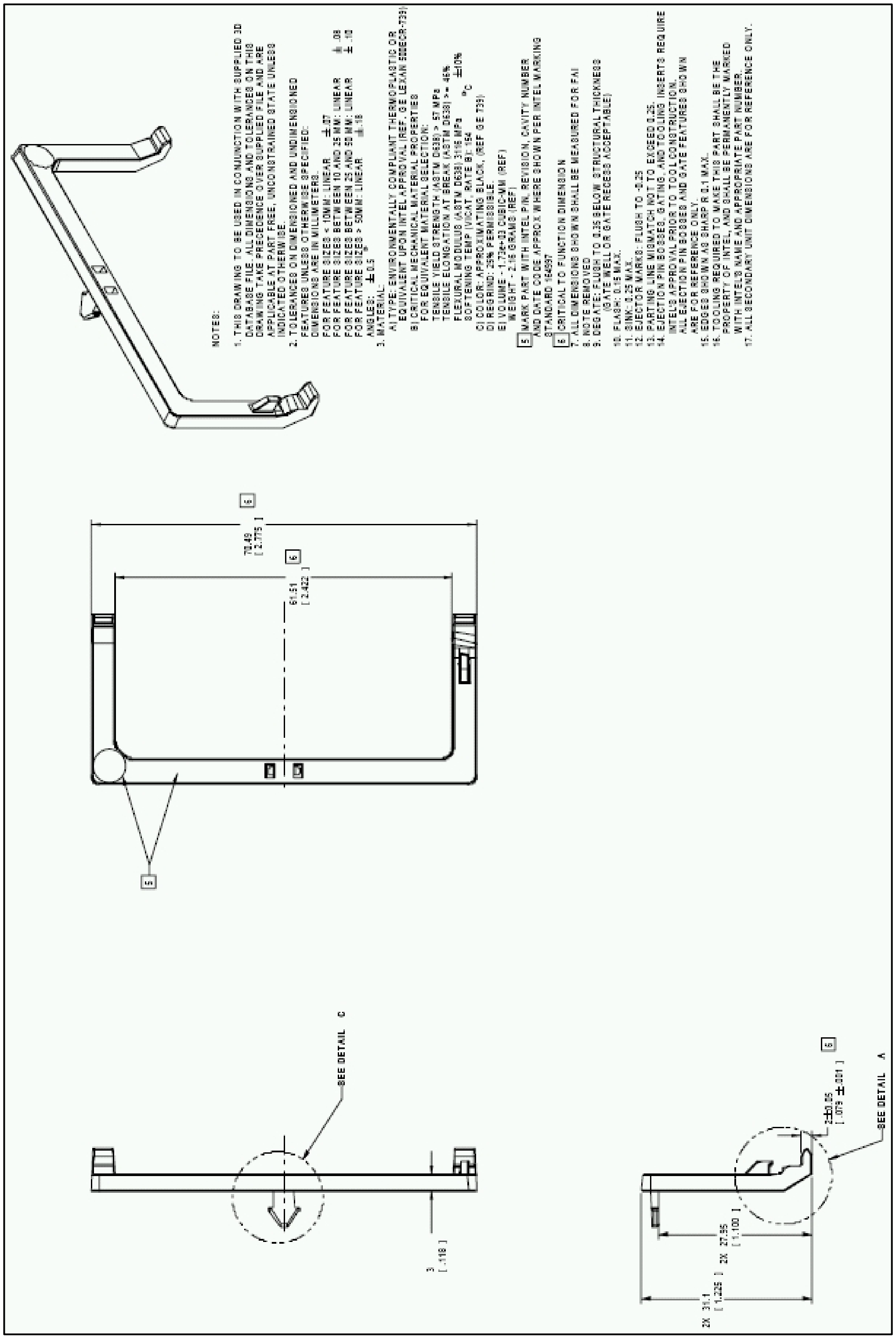


Figure 21. MCH Reference Heatsink for ATX Platforms - Ramp Retainer Sheet 2

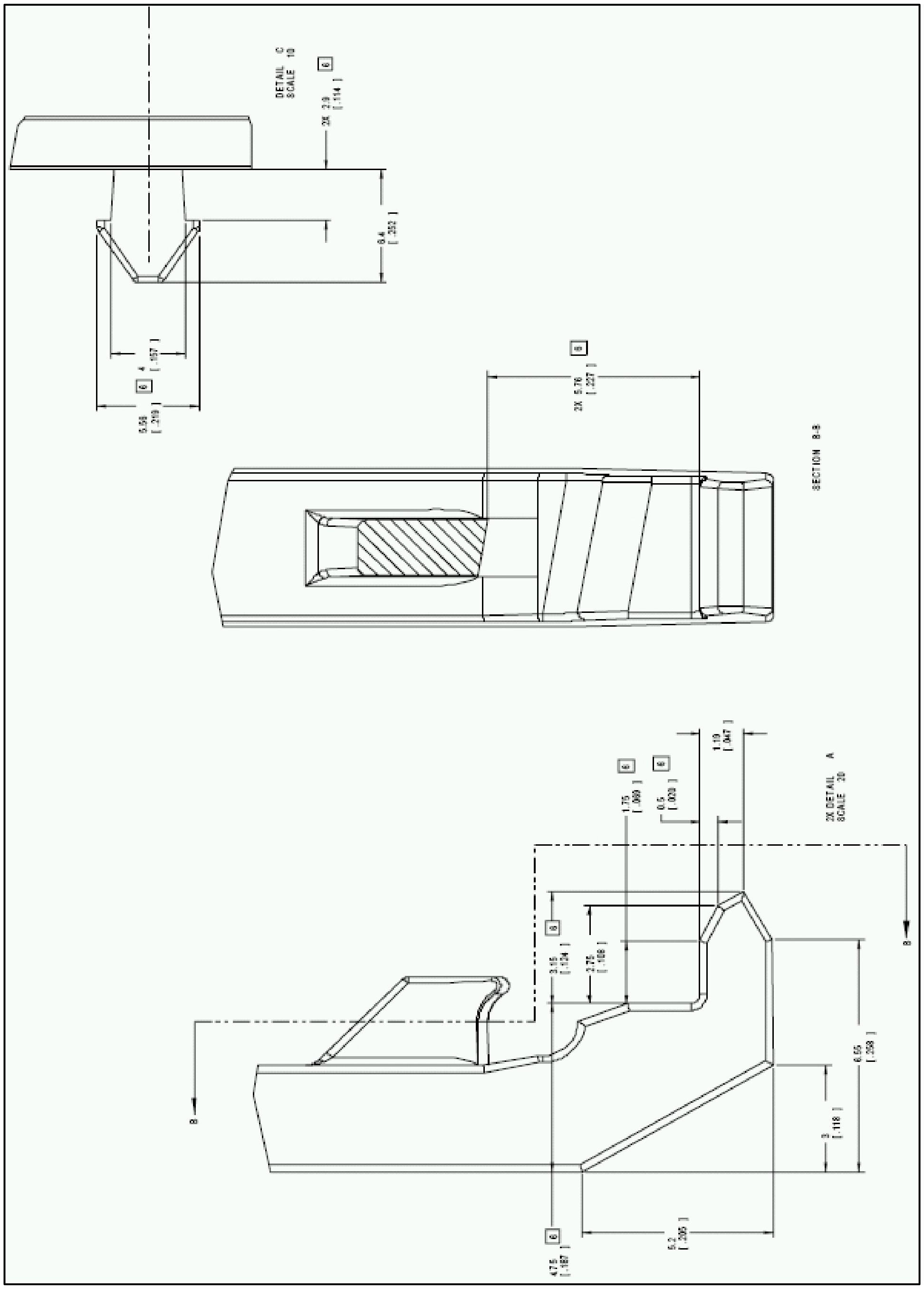


Figure 22. MCH Reference Heatsink for ATX Platforms - Wire Preload Clip

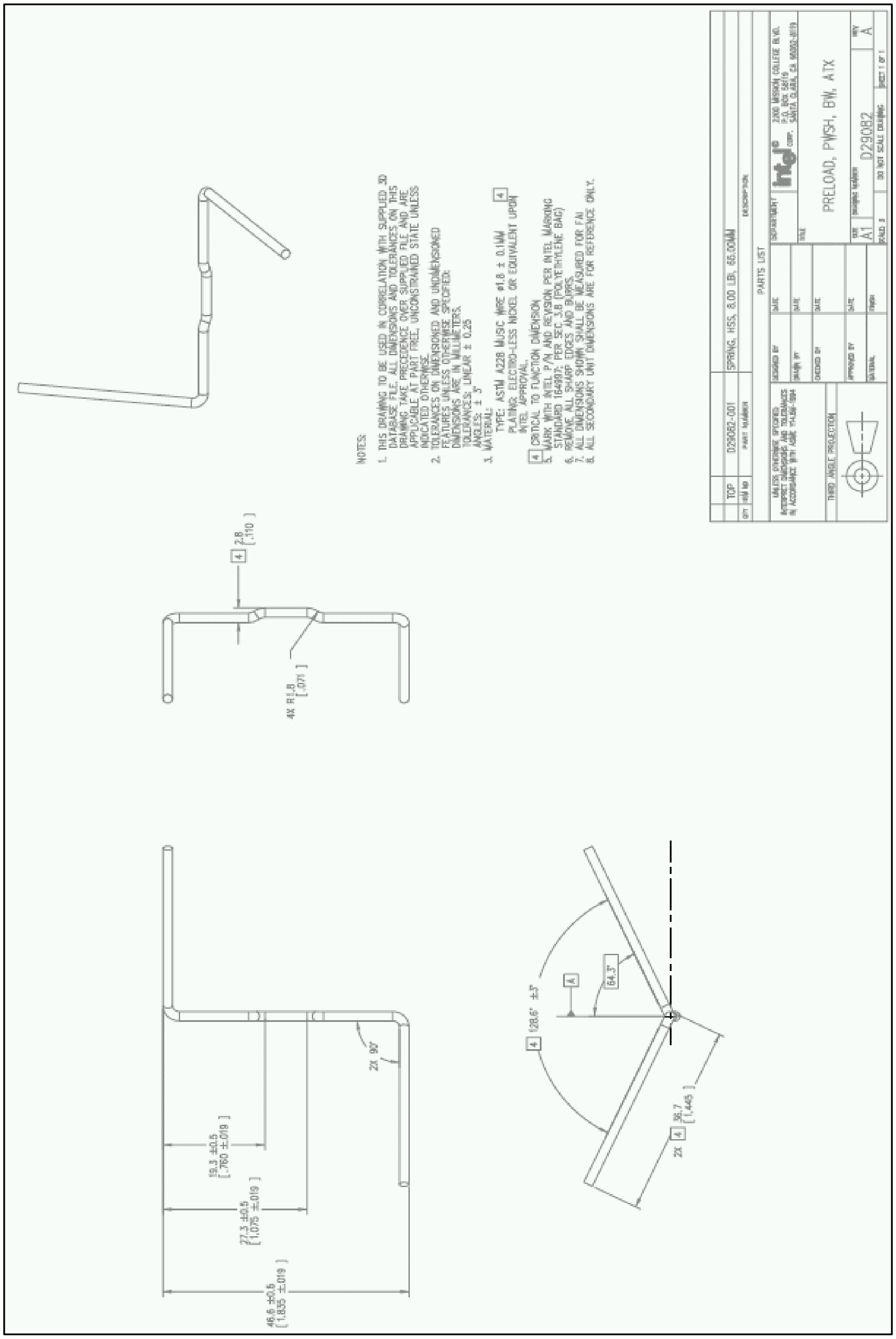


Figure 23. MCH Component Keep-Out Restriction for BTX Platforms

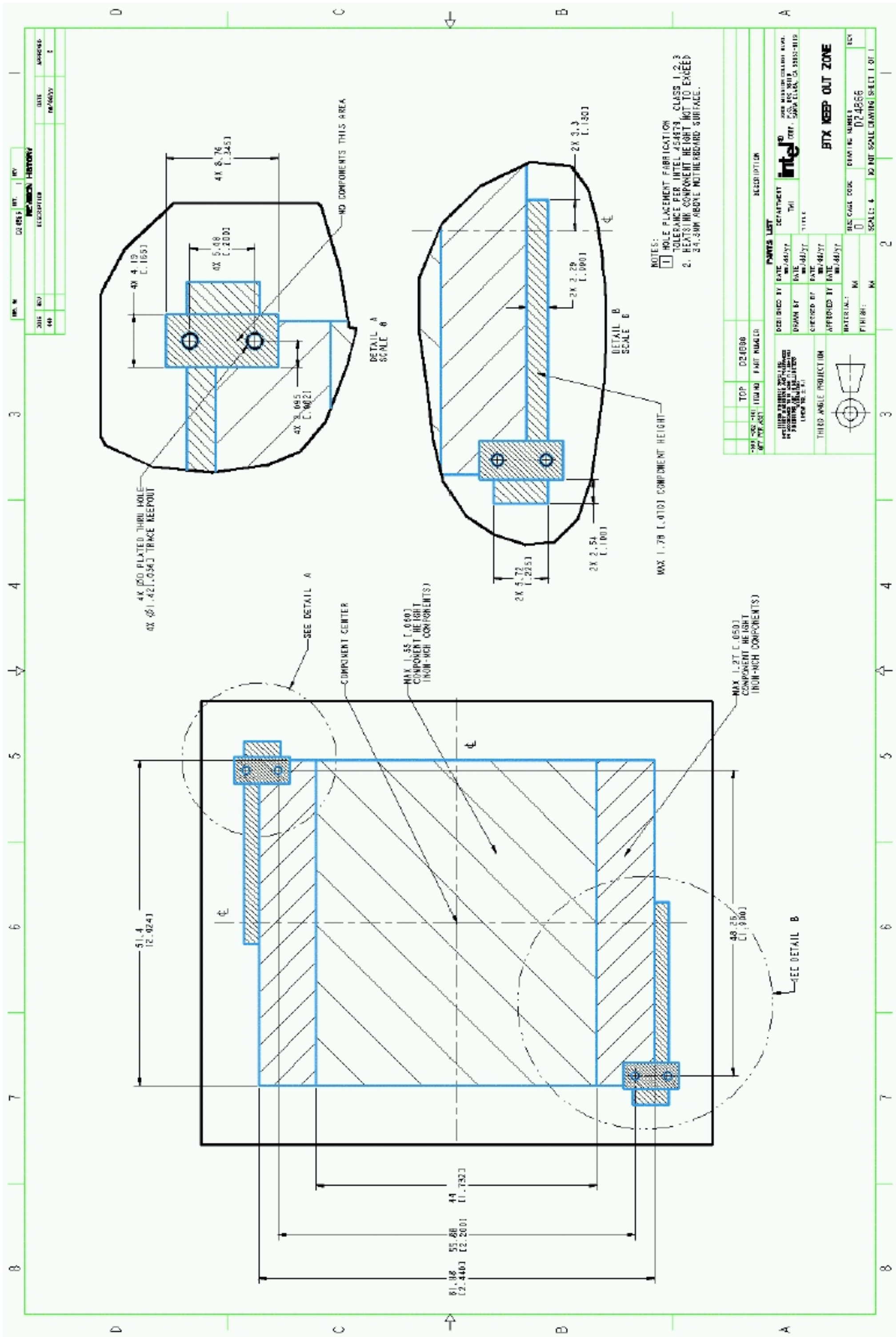


Figure 24. MCH Reference Heatsink for BTX Platforms

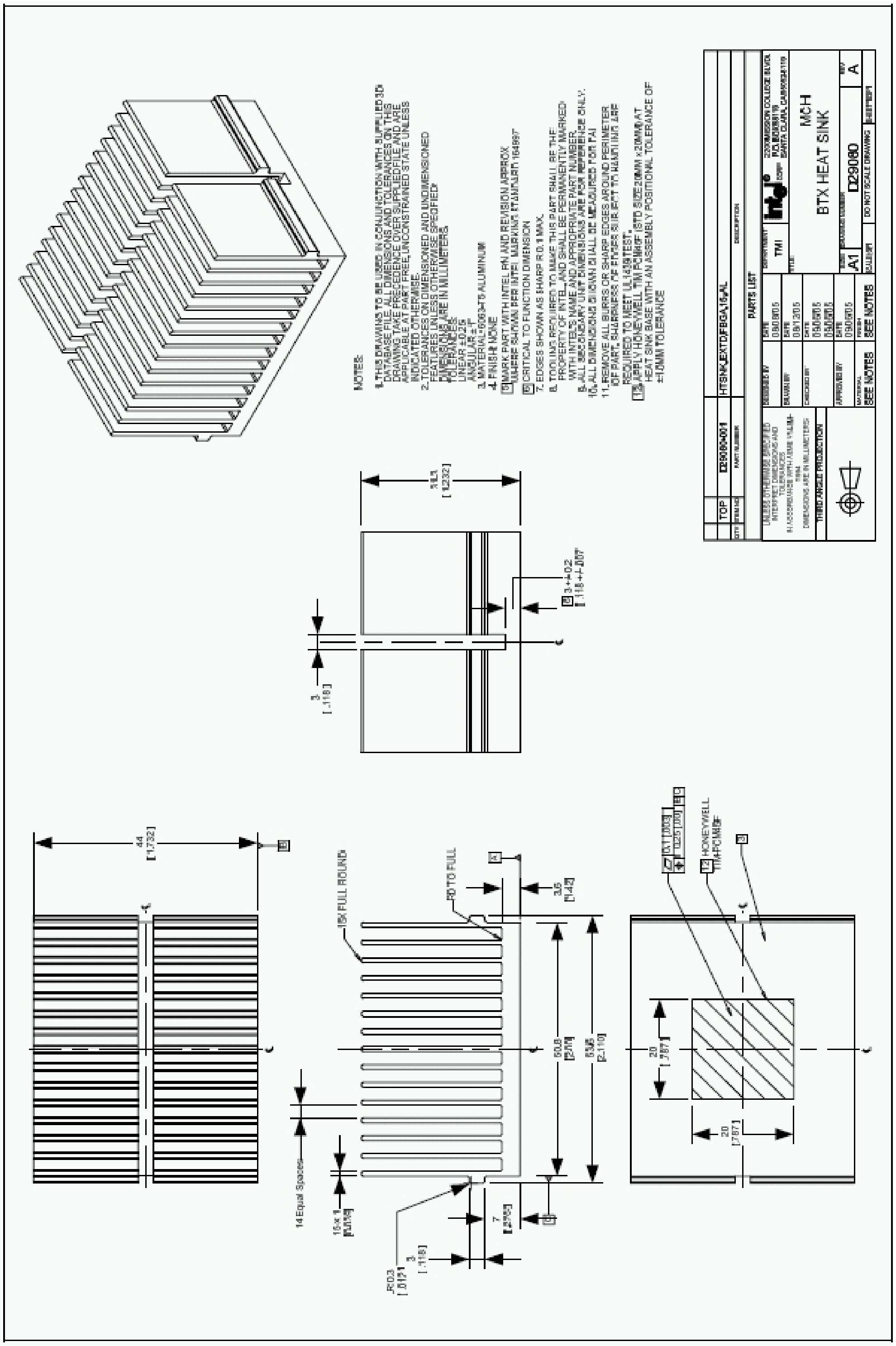


Figure 25. MCH Reference Heatsink for BTX Platforms - Clip

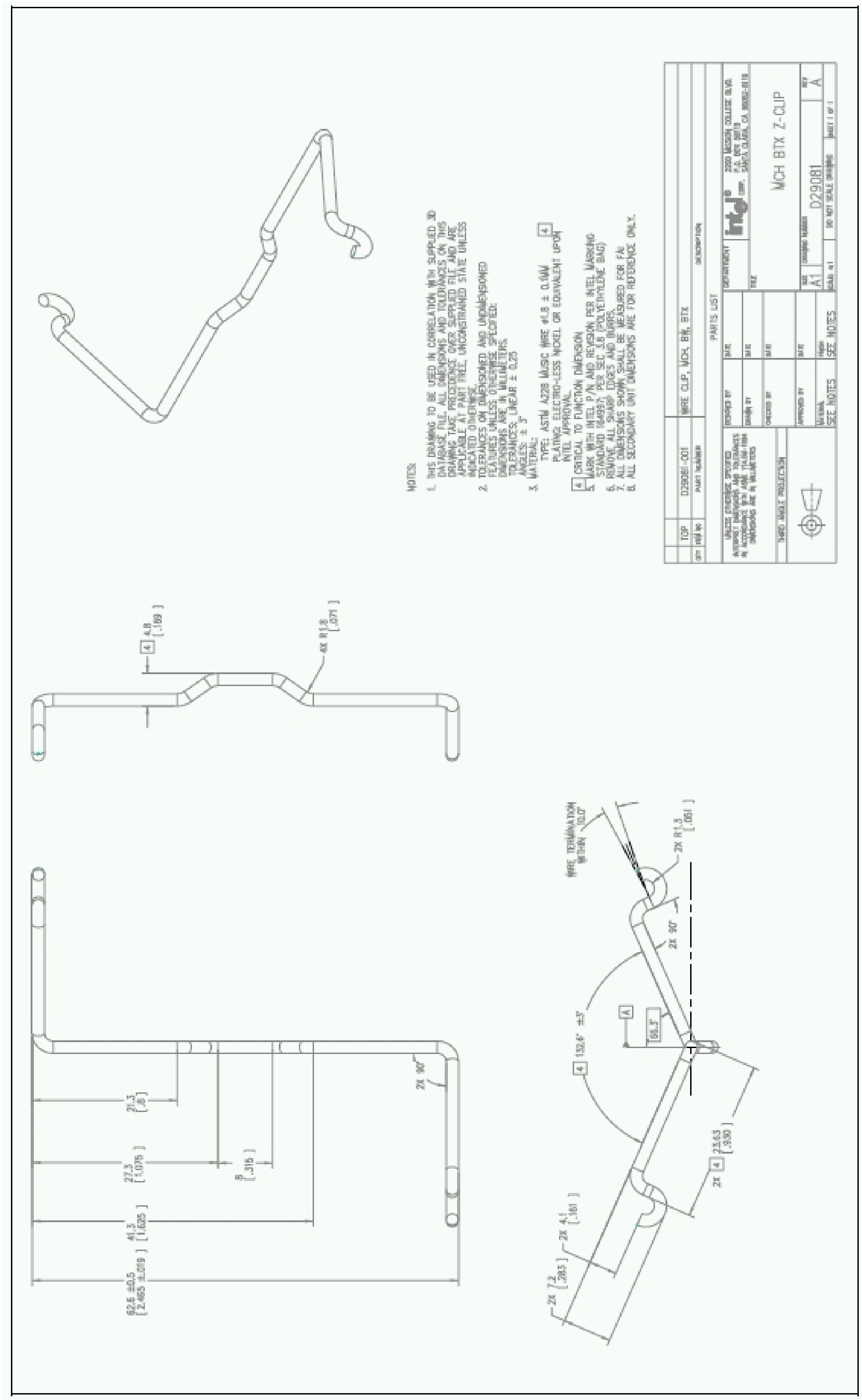
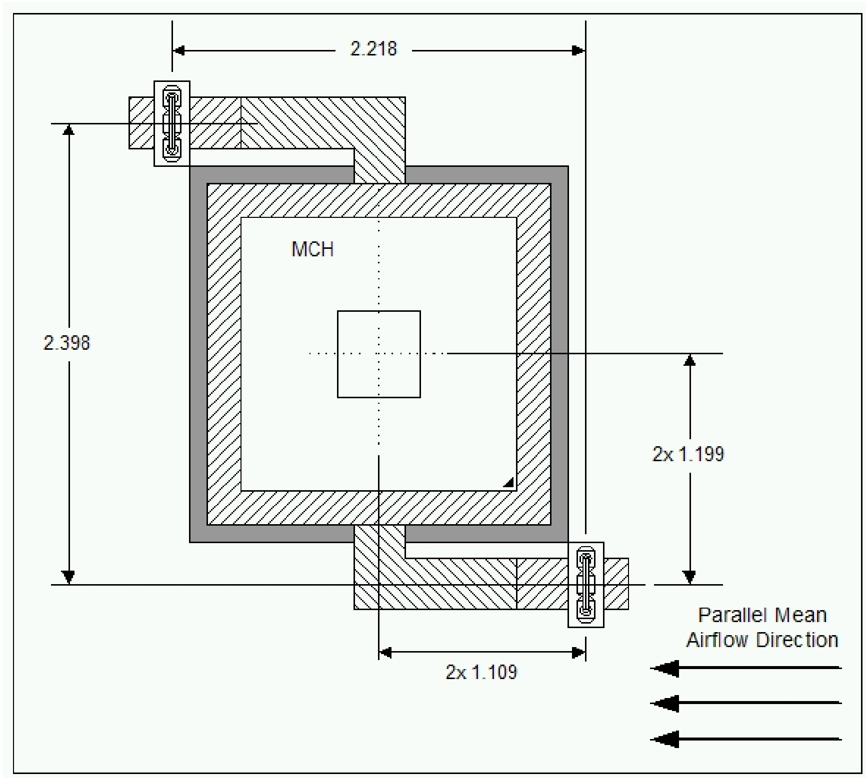


Figure 26. MCH Component Keep-Out Restriction for 1U/PICMG1.3 Platforms



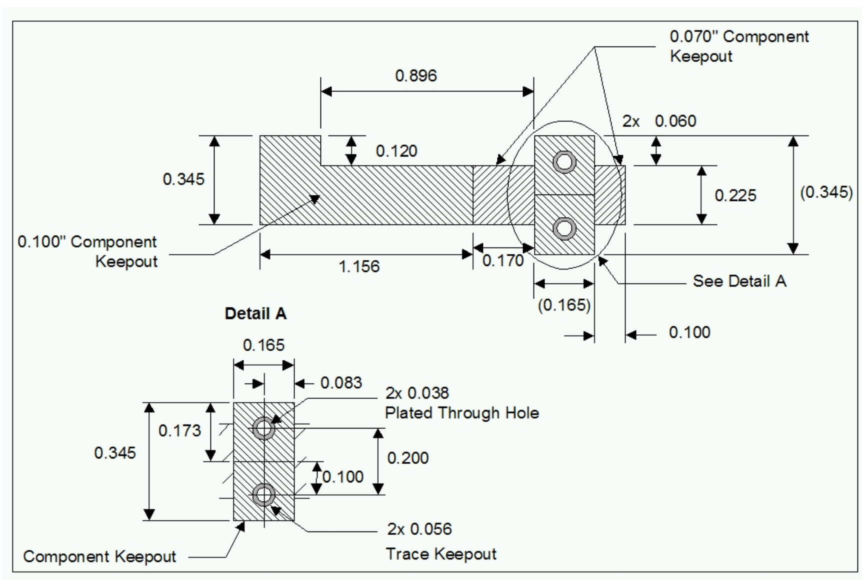
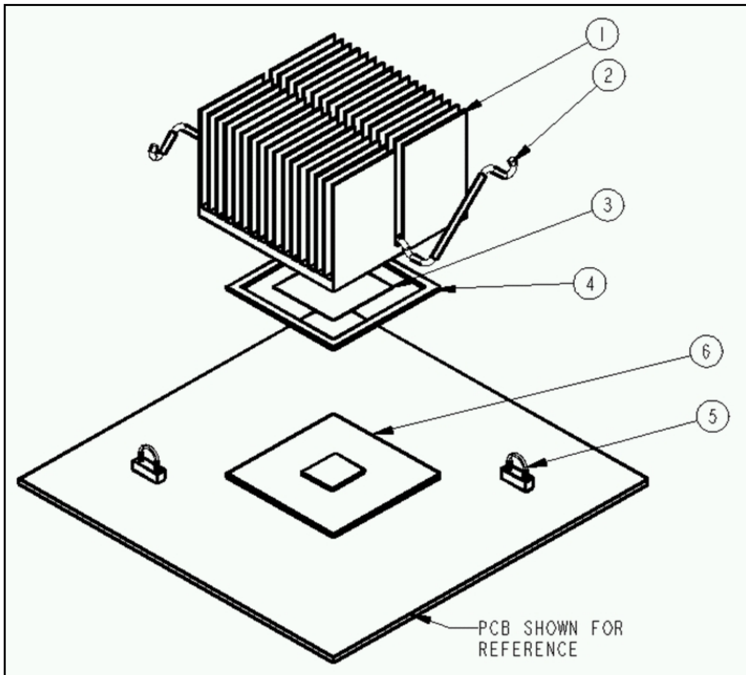


Figure 27. MCH Reference Heatsink Assembly for 1U/PICMG1.3 Platforms



1. Copper Heatsink
2. Heatsink clip
3. TIM
4. Gasket
5. MCH package
6. Anchor

Figure 28. MCH Reference Heatsink for 1U/PICMG1.3 Platforms

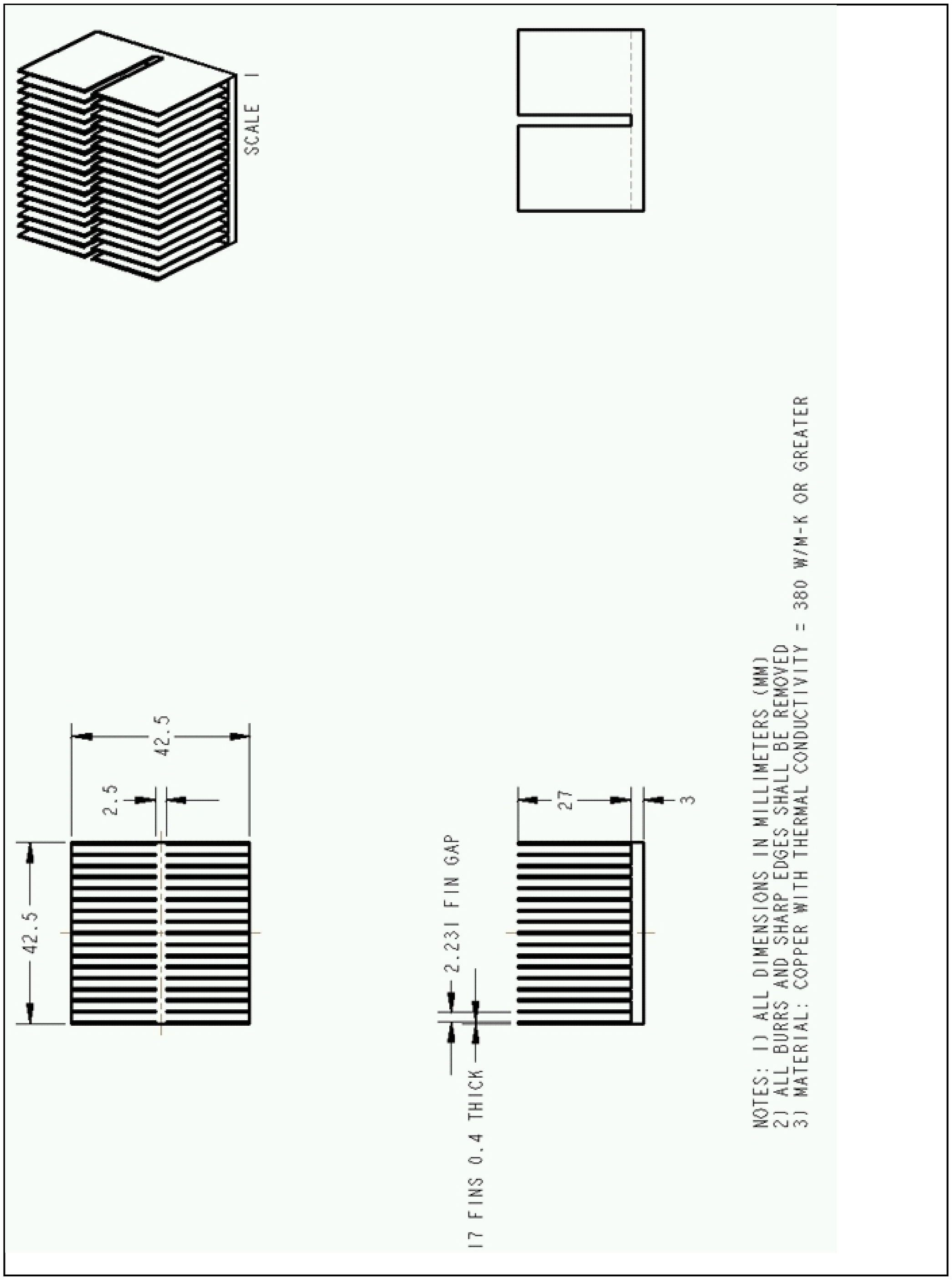


Figure 29. MCH Reference Heatsink Gasket for 1U/PICMG1.3 Platforms

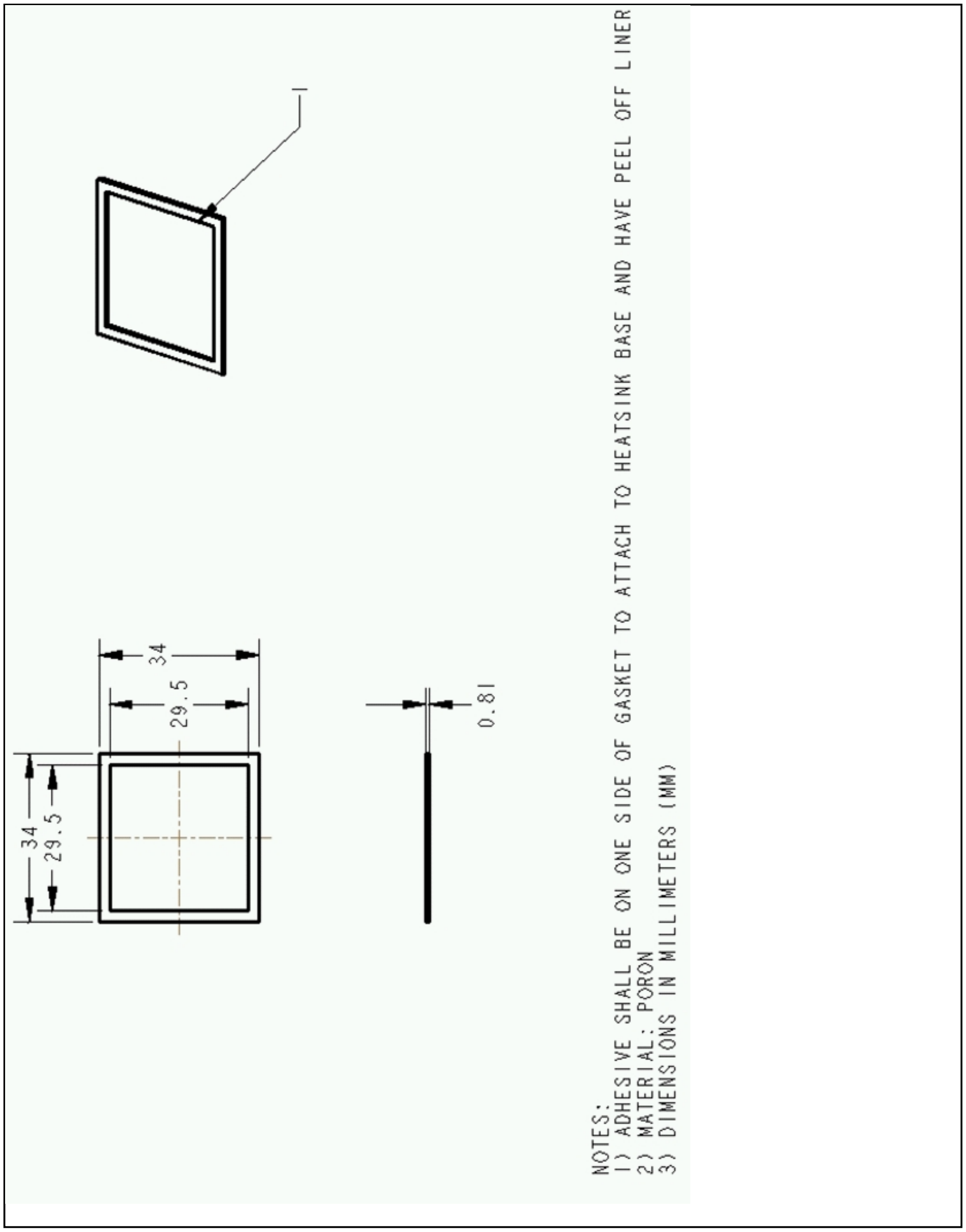


Figure 30. MCH Reference Heatsink Clip for 1U/PICMG1.3 Platforms